Rheology of Olivine with Different Grain Size

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Introduction: Rheological flow laws of mantle material play an important role in the dynamic behavior of the Earth's interior. Proposed mechanisms for flow range from dislocation mitigated power-law creep processes to diffusion-controlled linear phenomena. While dislocation flow proceeds nearly independently of grain size, diffusion and super-plastic mechanisms have a strong dependence on grain size.

Methods and Materials: We investigated the effect of grain size on olivine rheology from room temperature to 1500K at 8Gpa confining pressure. San Carlos olivine was ground and separated into two samples: one with 5-micron average grain size, the other with 0.5-micron grain size. These powders were stacked along the stiff axis of DIA cell separated and bounded by a thin gold foil. X-ray shadowgraph monitors sample length throughout the experiment, yielding strain rate for both samples.

Results: Both sample exhibit identical nonlinear rheological behavior. Each recovered sample has the same grain size as the starting material as shown by TEM.

Conclusions: These results suggest that very fine-grained olivine does not deform by either diffusion or superplasticity at subduction zone condition.